NATURE OF SCIENCE

# Planning an investigation

Teacher review edition. Ask your teacher if anything is unclear.

How can we plan a fair investigation?

## What you will learn

- Identify what to change, measure and keep the same.
- Write a clear, safe method with repeated measurements.
- Use results to answer the investigation question.

## Start with a question

> **Testable question**
> A question that can be answered using observations or measurements.

Science uses evidence to answer questions about the world.

- Evidence comes from observations and measurements.
- A testable question tells us what to compare and what to measure.
- Example: “Does water temperature affect the time taken for a sugar cube to dissolve?”
- Test it by measuring dissolving times at different temperatures.

## An explanation and a prediction

> **Hypothesis**
> A possible explanation that can be tested using evidence.

A hypothesis and a prediction have different jobs.

- Hypothesis: a possible explanation that can be tested.
- Example: sugar may dissolve faster in warmer water because the water particles move faster.
- Prediction: what we expect to happen in the test.
- Example: “The sugar cube will take less time to dissolve in warmer water.” Write this before collecting results.

## Make it a fair test

> **Independent variable**
> The factor we deliberately change in an investigation.
>
> **Dependent variable**
> The factor we observe or measure.
>
> **Control variables**
> Factors we keep the same to make a test fair.

A variable is a factor that can change. Change one factor and keep the other important factors the same.

| Type of variable | In the sugar investigation |
|---|---|
| Independent: what we change | Water temperature |
| Dependent: what we measure | Time taken for the sugar cube to dissolve |
| Control: what we keep the same | Water volume, size of sugar cube and method of stirring |

## Write a clear method

A method should let someone else repeat the investigation.

- List the equipment, amounts and measurements.
- State when to start and stop timing. Here, stop when no solid sugar is visible.
- Repeat each temperature at least three times and calculate the mean time.
- Compare the repeated results. Large differences may suggest a problem with the method or timing.

## One route through an investigation

1. Ask a testable question

↓

2. Plan a fair test

↓

3. Measure and record results

↓

4. Use evidence to draw a conclusion

Use the conclusion to improve the method or ask a new question. Scientists may revisit earlier steps.

### Work safely

> **Risk control**
> An action that reduces the chance or seriousness of harm.

A hazard can cause harm. A risk control reduces the chance or seriousness of that harm.

- Hot water can burn skin: use temperatures and equipment approved by your teacher.
- Spills can cause slips: keep containers away from bench edges and clean up spills.
- Never taste laboratory materials.
- Choose a different method if the investigation could harm people, animals or the environment.

### Use the results honestly

Results are useful even when they disagree with a prediction.

$$\text{mean} = \frac{\text{sum of the readings}}{\text{number of readings}}$$

- Record every result, including unexpected ones.
- Compare the results with your prediction.
- If they disagree, check the method and consider another explanation.
- Science also uses fieldwork, research and models. A result may lead to a new question or a revised plan.

## Worked examples

Three sugar cubes take 41 s, 43 s and 42 s to dissolve at the same temperature. Find the mean dissolving time.

### Work through it

1. Add the three times: 41 + 43 + 42 = 126 s.
2. Divide by the number of trials: 126 ÷ 3 = 42 s.
3. The mean dissolving time at this temperature was 42 s. Compare it with the mean at another temperature.

$$\text{mean} = \frac{41 + 43 + 42}{3} = 42 \text{ s}$$

## Common mistakes

**Common mistake:** Changing two factors makes the test better.

**Remember:** If temperature and sugar-cube size both change, either could cause the different dissolving time. Change one factor at a time.

**Common mistake:** A result that disagrees with my prediction should be deleted.

**Remember:** Keep it, check for a mistake and investigate why it differs. Do not choose only results that support your prediction.

## Answering questions

- When planning a test, name what you change, what you measure and at least two factors you keep the same. Use the actual quantities in the question.
- Give a precise stopping point, such as “when no solid sugar is visible”, and explain how repeats and a mean will help you compare results.

## Try an investigation

With your teacher, plan a dissolving investigation using three safe water temperatures. Write down the variables, the equipment, when you will stop timing and how you will repeat the test.

### Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.